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AGU AUTOBIOGRAPHY - PART TWO. George Lawson Pickard.

September 19, 1997

My interest in science, and Physics in particular, was developed by an enthusiastic physics teacher, recently down from Cambridge, in my last two years at school. As well as being an interesting teacher in class he had us carrying out experiments far beyond the regular syllabus, *e.g.* with cathode ray tubes - remember that this was in 1931/2), speed of waves in water.

I was fortunate to gain a College Scholarship to Oxford in 1932 and with two other scholarships I went up in October, 1932, taking Mathematics Moderations in my first year and Physics Finals in June, 1935. (In those days, the Special Subjects from which one could elect one included only 'Electromagnetism' and 'Atomic Physics'!) Having obtained a First Class I was permitted to proceed to graduate work, gained a Graduate Scholarship, and started work with Prof. F.E.Simon and completed a thesis on a "Quantitative Study of the Helium Expansion Method for Cooling" and on "Measurements of the Specific Heats of some Metals below 1°K" for Prof. N.F. Mott, gaining my D.Phil. degree in October, 1937.

After this I spent about a year working with Dr. R.V.Jones on techniques for the detection of aircraft by the infra-red emission from their engines. (For this work I was formally employed by the Air Ministry as a Junior Scientific Officer.) This approach was abandoned as RDF (= RADAR) became practical. I was then (1938) posted to the Royal Aircraft Establishment, U.K. as a Scientific Officer where I worked on techniques for low- and high-level bombsighting, dive bombing (in a Ju 88), visibility of aircraft day and night. I developed a two light-beam altimeter to facilitate maintenance of 50 feet height above the sea at night for Coastal Command attacks on submarines. (Before the days of radio altimeters.) This technique was used later during the attacks on dams by the RAF. (In 1941, I was appointed (!) local assistant to Prof. P.M.S. Blackett who came down to R.A.E. once a week to consult on matters related to the war. He frequently set me a task to be completed by his next visit and almost as frequently by the next week had rejected that idea and thought up a new one.) In 1942, I was posted to Operational Research, R.A.F. Coastal Command, as the scientific adviser to the Coastal Command Development Unit (later the Air-Sea Warfare Development Unit) which was responsible for trials of tactics and equipment for anti-submarine attacks. Initially I flew as observer on all Unit trials flights but later accumulated up to four assistants. (I was posted as Hon. Squadron Leader, R.A.F. to permit me to wear uniform on operational flights outside the U.K., *e.g.* to Gibraltar several times, Iceland, Arctic Circle and open ocean flights. I eventually rose to the rank of Principal Scientific Officer.

In 1947, after V.E. Day, the probability of a posting to an office job in Air Ministry caused me to look for alternative opportunities. I applied to the University of British Columbia, Vancouver, Canada, and was offered a position as Associate Professor in the Physics Department. I accepted, and we (with wife and two children) sailed for Canada on August 31, 1947. Just before leaving the U.K. I learned that I had been appointed a Member of the Order of the British Empire (M.B.E.)

On arrival at U.B.C., I was informed that there were no facilities for low temperature research there. (As an aside, the Department acquired a Collins Helium Liquefier one year later !) I took on a Ph.D.student for a study of the vapour pressures of metals which had no relation to my subsequent work but who moved to the National Research Council and later developed an automatic electrical salinometer which was used world-wide when developed for production.

In early 1948, I met Dr. John P. Tully of the Pacific Oceanographic Group of the Fisheries Research Board of Canada based at Nanaimo, B.C., and agreed to accompany him on a three months oceanographic field study that summer in northern British Columbia. This was my introduction to the Oceanography aspect of Geophysics, a field in which I continued in several aspects until my retirement in 1979. In 1948, the University decided to initiate studies in Oceanography by setting up an Institute of Oceanography in the Faculty of Graduate Studies and I, of course, joined this group. At that time, the study of estuaries (defined by Dr. W.M.Cameron, one of our group, and Dr. D.Pritchard) as "semi-enclosed coastal bodies of water having a free connection to the open sea and within which sea-water is measureably diluted with fresh water derived from land drainage.") was becoming popular. The

main feature of the west coast of Canada (and of Alaska) is the presence of a large number of fjords, which are one class of estuaries, and we (members of the Institute) decided that the study of these fjords was an appropriate one for our small group as the fjords were on our doorstep, so to speak, and the ships available to us were likely to be relatively small vessels (25 to 35 m length). Of course we were aware of the classical and recent studies in the Norwegian fjords. In British Columbia a few minor studies had been made prior to 1947 but our group now planned to make systematic studies over many years and in some cases year-round studies. Observational studies of the fjords occupied much of my research time until about 1975, mostly summer cruises in the fjords of B.C. and of Alaska (prior to the entry of the University of Alaska into this field) to provide both research material for myself and students and practical field experience for the students. Our field studies started in 1951 with an extensive investigation of most of the fjords along the coast of British Columbia.

The funds for this research (equipment, salaries for assistants, *etc.*) have mainly been made available as research grants initially from the Defence Research Board of Canada and later from from the National Research Council of Canada. Research ship time was made available by the Royal Canadian Navy and later by the Fisheries Resarch Board of Canada. During my second year in Canada I spent a winter session at Scripps Institution of Oceanography to learn something of the practice of oceanography and the current fields of research in the field. The same year I spent a couple of months at the Woods Hole Oceanographic Institution to get acquainted with the researchers there and their fields of interest.

In 1970, the opportunity arose to make a systematic investigation (physical, chemical and biological) of the previously unstudied Chilean fjords as a part of the Canadian *'HUDSON 70'* Expedition Around the Americas from February 26 to April 9, 1970. I was Chief Scientist for this section of the cruise from Punta Arenas to Valparaiso (including 35 fjords and of the north-south passage along the inner coast) and to and from Isla Juan Fernandes. In 1977, I was invited and took part in the first systematic oceanographic study by the New Zealand Oceanographic Institute of all of the New Zealand fjords accessible to a ship (15).

Material related to my fjord work may be found in PUBLICATIONS, (a) #4-15,17,18,23-26,28 and (c) #9,10, supplied earlier with my *Curriculum Vitae*.

I now summarize briefly the instruments used in our fjord work. From 1950 on, salinity and dissolved oxygen were determined on board, the former by the Mohr method (titration with silver nitrate) and the second by the Winkler method. In 1967 we obtained one of the early Auto Lab Inductively Coupled salinometers for use on deck (to about 0.003 °/oo ). In about 1970 we obtained a simple *in situ* temperature/salinometer/depth recorder which was useful in helping to interpolate between bottle sample depths. In the early days, we measured currents with a Chesapeake Bay Drag for the upper layers and with Ekman Current Meters at greater depths. In fact, I may well be the last living oceanographer to have measured current profiles with that device and to have published a paper with results obtained with it (Publications, (a) 13). Of course, younger members of my Institute in later years have used much more sophisticated *in situ* salinometers and long-period recording current meters and profiling instruments. In the last three decades, there has been wide use of computers in the handling of data and in simulations.

In 1966, at a meeting in Tokyo, I made the acquaintance of Henri Rotschi who was Head of the Oceanographic Section of the O.R.S.T.O.M. group in Nouméa, New Caledonia. His group had started what was probably the first systematic series of trans-equatorial cruises at about 170°E. This intrigued me and I obtained permission to visit Nouméa which I did for the first time in 1967 for about three months, taking part in one of their CYCLONE series of cruises - my first experience of open ocean oceanography. In 1971 I visited Nouméa for a second transequatorial cruise, at 155°E. These cruises resulted in two minor contributions with members of the ORSTOM group (PUBLICATIONS (a) #21,22).

In 1961, my wife and I visited Tahiti and associated islands *(en route* to Hawaii), for the first time, on one of the first direct flights from North America. This was just a personal holiday but it opened my eyes to another

aspect of physical oceanography because I noticed some features of the circulation inside the reefs of that island and others in the Society Island group. When I returned the Vancouver, I started to search the literature related to coral reef islands and was surprised to find how little work had been done to that time by physicists in such areas. This suggested a possible line of research but I did not take any action for some years although I visited some 60 coral fringed islands or atolls in the three oceans during the following years. In 1971 while in Australia I visited the recently formed Australian Institute of Marine Science (AIMS) in Townsville, Queensland, whose prime interest was in the study of the Great Barrier Reef (GBR). This was when my practical interest in the physical oceanography of coral reef areas began to develop.

In 1975/76, the possibility of a sabbatical came up, and after an enquiry I was invited to visit A.I.M.S. to prepare an account of what was known of the physical oceanography of the GBR (as they had no physical oceanographers on staff at the time). In preparation, I assembled all the data available in local libraries on reef oceanography both of the GBR and of other islands - not a great deal. Then my wife and I travelled east-about to Australia for a preliminary visit to AIMS to discuss my plans and then to other marine laboratories in Sydney and Cronulla for further data related to the GBR. Then we crossed to Nouméa for a third visit to ORSTOM to search their files for unpublished data (of which earlier visits had made me aware) about the Western Coral Sea which lies off the GBR. The MSS on the GBR was assembled in Nouméa and tidied up when we returned to AIMS. It was published by AIMS as their Monograph No.2, *'A Review of the Physical Oceanography of the Great Barrier Reef and Western Coral Sea', 1977*, (POGBR I).

This was followed by six more visits to AIMS, totalling about 18 months, to take part in field studies of the GBR between about 20°S and the Gulf of Papua, analysis of data, and preparation of papers. Most of this was done in collaboration with Dr. Eric Wolanski who had joined AIMS after my first visit. (PUBLICATIONS (a) #27-33). One solo study was of the circulation at Davies Reef (#34) made to provide background data while a group of microbiologists were carrying out research at that reef. In 1986 I spent about four months assembling a follow-up to POGBR I describing the extensive physical oceanographic studies which had been carried out since POGBR I (1977). Unfortunately, due to problems in the Publishing Section at AIMS, this manuscript was never published. However, a general account of the physical oceanography of Coral Reefs in general was assembled in 1976/77 by Dr. J.C.Andrews of AIMS and myself and published in 1990 as a chapter in *ECOSYSTEMS OF THE WORLD, Vol. 25, CORAL REEFS* (Publications, #35). This chapter includes a fairly complete Bibliography of physical studies of reef areas up to 1985.

While working in Australia, I made the acquaintance of a number of Australian marine scientists, among them being Bruce Hamon of the C.S.I.R.O. Laboratory at Cronulla, who developed the first practical electrical salinometer for over-the-side work. Another with whom I had frequent contact, including one cruise northward in the GBR was Dr. Jason Middleton who himself and in collaboration with Dr. Wolanski, and with students, carried out seminal studies of the dynamics of the circulation in the GBR.

In 1960, while attending a meeting of the Association of Physical Oceanography during the I.U.G.G. meeting in Toronto, Canada, Dr. J. Tuzo Wilson approached Dr. J.A.Jacobs and I (and possibly others) with a suggestion that we should consider preparing introductory but up-to-date graduate level texts in our respective fields as part of a series planned by Pergamon Press. At that time there were relatively few such texts, the best known being the omnibus *'The OCEANS'* by Sverdrup, Johnson and Fleming, and I was willing to try to prepare something less expensive and, where possible, more up-to-date than that volume. On the basis of the lecture notes which I had assembled and provided to students, my contribution to the new series was *Descriptive Physical Oceanography* published first in 1967. This text has gone through five editions, the last two with Co-Author Dr. W.J.Emery, and a total of some 55,800 copies have been sold. This text was translated into Malaysian in 1993. At the time when I prepared the first edition of DPO, a colleague had agreed to prepare a similar volume on the dynamic aspects of physical oceanography. Time passed, and eventually, with the agreement of the said colleague, Dr.G.Stephen Pond in my group at U.B.C. agreed to join with me in preparing the dynamics volume in the form of *Introductory Dynamical Oceanography*, first published in 1978 with a second edition in 1983. These editions have sold a total

of 20,160 copies. These texts have been used at U.B.C. for both fourth year undergraduates and for first year graduates.

For several years (1962-75) I became involved with the Tsunami Warning Service for the Pacific, not because I was any authority or researcher in the field but chiefly because I was available on the West Coast to represent Canada for the early years of the Group (of representatives of the U.S., Canada, Japan and Russia) which met biennially to discuss the development of the System. I was Vice-Chairman of this Group and had to act as Chairman several times when the (Russian) Chairman was delayed in arriving at the meeting. My membership of other Committees is listed in my CV.

One consulting position which I was asked by Canadian authorities to accept was to visit Bangladesh to advise on the possible development of an Oceanographic Institution in that country. I met with senior representatives of the Government and of the Universities at Dacca and at Chittagong and was hospitably entertained. Their plans were essentially for an organization of magnitude similar to the total effort in oceanography and fisheries in the whole of Canada, government and universities combined, and I had to report that I felt that they were far too ambitious, both in personnel required and equipment (ships and research equipment) particularly considering the difficulty of maintaining the latter at their distance from sources of supply, a feature of which I had previously become aware in, for instance, New Caledonia.

It may be interesting to note that although I only got into the field of Oceanography in 1948, by the mid-1950s I believe that I had met in person almost all of the physical oceanographers in North America and many of those in the United Kingdom and Europe - an indication of the relatively small group in this field at that time. By now, the population in the field of physical oceanography has probably increased a hundred-fold or more from that time.

During my thirty-one years (twenty-one as Director) with the Institute at U.B.C., my colleagues included Dr. W.M.Cameron who joined us from the Fisheries Research Board, Dr. R.W.Stewart who joined us from the Defence Research Board and left to a senior post with the Government and later as founder of a marine institute at the University of Victoria, and Dr. W.J.Emery whom I have mentioned before and who moved to the University of Colorado. Incidentally, the Institute of Oceanography started as a part of the Faculty of Graduate Studies but eventually became a full Department in the Faculty of Science after we had been presenting undergraduate courses for several years.

[Correction to the Publication List with my C.V. - Item (a) 15 should be dated '1961'.]

Dated 20 Sept. 1997. G.L.Pickard